

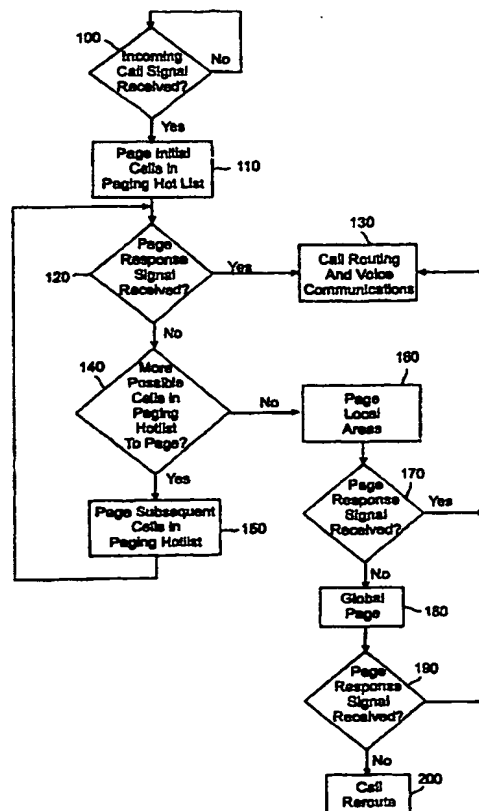


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| (21) International Application Number: PCT/SE98/01165 (22) International Filing Date: 16 June 1998 (16.06.98) (30) Priority Data: 08/880,166 20 June 1997 (20.06.97) US (71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE). (72) Inventors: ANDERSSON, Mikael; Björkliden 69, S-586 65 Linköping (SE). WESTROOS, Anders; Bjälbogatan 8C, S-582 47 Linköping (SE). ÖSTRUP, Peter, Nils; Kagagatan 5, S-582 47 Linköping (SE). (74) Agent: ERICSSON RADIO SYSTEMS AB; Common Patent Dept., S-164 80 Stockholm (SE). | | (81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> |

(54) Title: METHOD AND SYSTEM FOR PAGING A MOBILE STATION**(57) Abstract**

In a mobile communication network including at least one mobile switching center and at least one mobile station, a method and system are provided for paging a mobile station. A list of cell-identifying information representing possible locations of the mobile station is established by making contact between the mobile switching center and the mobile station, determining a cell in which the mobile station is located, and adding information identifying the cell in which the mobile station is located to the list. The mobile station is selectively paged within each of the cells identified by information in the list until a response is received.



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METHOD AND SYSTEM FOR PAGING A MOBILE STATION

BACKGROUND

This invention relates to methods and systems for mobile communication, and more particularly to methods and systems for paging mobile stations.

5 The goal of a mobile communication network is the interconnection of mobile stations with the Public Switched Telephone Network (PSTN) via a Mobile Switching Center (MSC) and a Radio Base Station (RBS). Successful achievement of this goal requires that each mobile station or other remote station in the network be accessible at any given time. Hence, the problem of locating a mobile station moving from one area to
10 another within a wide geographic area has become one of primary importance.

In a mobile communication network, there is a level of uncertainty regarding the precise position at which a mobile station is located at a given moment. A paging function is used to call a mobile station to find the station in the network. The page is broadcast upon a paging channel, which has a limited capacity. Thus, there is a need to
15 limit the number of pages broadcast.

One method commonly employed to determine where to page a mobile station and thus limit the number of pages broadcast is mobile registration. According to this method, a mobile station reports its location to the MSC by sending registration reports via the RBS. The mobile station is subsequently paged at the location at which it is
20 registered.

Various systems have been proposed to handle mobile registration. For example, U.S. Patent No. 5,506,886 to Maine et al. discloses a paging system that allows a subscriber to call a destination controller and transfer subscriber identification and location information to the system. Thereafter, the system transmits a paging signal to
25 the subscriber only at a location corresponding to the transferred location data.

Conventional mobile registration is based on a single location concept, which is to say that whenever a mobile station moves from one local area to another, the registration in the old area is canceled, and a new registration is established in the new area. The

MSC keeps track of only one location, the area in which the mobile station was most recently registered.

The single location concept does not fully take into account some of the limitations of radio technology. Often in mobile communication systems, telephone calls to a mobile station cannot be completed because the mobile station is registered in one area but is actually located in another area. This can happen, for example, because the mobile station has not had time to renew its registration before the telephone call is initiated. To overcome this problem, the mobile station must register its location often, which can overload the registration channels.

To reduce the need for registration by the mobile stations, Location Areas have been defined in many mobile communication networks. A Location Area corresponds to a group of one or more cells in which a mobile station can move freely without updating its location. The Location Area registration is updated every time the mobile station enters a cell belonging to a new Location Area. The mobile station performs this updating by transmitting a registration report to the network when entering a new Location Area. In addition to registering upon entering a new Location Area, mobile stations may perform periodic location registration.

In the CMS30 system made by Ericsson Radio Systems AB and described in CMS30 System Survey, Doc. No. EN/LZT 123 1057 R1A (1993), location registration is performed by a mobile station each time the mobile station enters a new Registration Location Area. In the interest of simplicity, the terms "Location Area" are used herein to describe both a Location Area and a Registration Location Area.

A problem with such location registration is that a mobile station may move from one Location Area to another without renewing its registration. In addition, if the mobile station is located beyond the range of the communication system or is turned off, the mobile station cannot detect or acknowledge the page. Also, if the mobile station is temporarily not tuned to the paging channel upon which the page is broadcast, the mobile station is unable to detect the page. Therefore, the page has to be broadcast again, which presents a problem for a limited capacity paging channel. Thus, there is a need to increase the paging area to include areas other than the Location Area in which a mobile

station is currently registered while minimizing the number of pages broadcast to the mobile station.

Several systems have been proposed for paging areas in which a mobile station is likely to be found. For example, U.S. Patents No. 5,369,681 to Boudreau et al. and
5 No. 5,533,094 to Sanmugan each disclose a paging system that broadcasts the paging signal only to locations or cells where a mobile station is most likely to be found or located. Similarly, U.S. Patent No. 5,153,902 to Buhl et al. discloses a method in which previous mobile station registrations are used to determine where to page the mobile station. According to the Buhl et al. patent, registration information is stored in a list in a
10 home exchange when a mobile station registers. When the mobile station registers again, the new registration information is added to the list. Consequently, the list reveals the current registration of the mobile station as well as prior registrations made by the mobile station. The list is used by the home exchange to determine a suitable paging area.

A problem with systems such as these is that the paging areas typically employed
15 are Location Areas, which can be quite large. For example, in the CMS 30 System, the Registration Location Areas each contain up to sixty four cells. For mobile stations that do not move around much in the network, a smaller paging area would generally be sufficient and would be more efficient in using the limited paging channel resource.

There is thus a need to reduce the size of the paging area in a mobile
20 communication network while minimizing the number of mobile station registrations.

SUMMARY

According to the invention, methods and systems are provided for paging a mobile station. A list of cell-identifying information is established representing the
25 possible locations of the mobile station. The list is established by making contact between the mobile station and the mobile switching center, determining a cell in which the mobile station is located, and adding information identifying the cell in which the mobile station is located to the list. The mobile station is selectively paged within each cell identified by information in the list until a response is received.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will now be described in more detail with reference to the accompanying drawings, in which like descriptive labels are used to refer to similar elements and in which:

5 Figure 1 is a functional block diagram illustrating a mobile communication network according to an exemplary embodiment of the invention; and

 Figure 2 illustrates a method for paging a mobile station according to an exemplary embodiment of the invention.

DETAILED DESCRIPTION

10 In this description, specific details such as particular circuits, circuit components, techniques, etc., are set forth for purposes of explanation and not limitation in order to provide a thorough understanding of the invention. It will be apparent to one of ordinary skill in the art that the invention may be practiced in other embodiments that depart from
15 these specific details. Details of well known methods, devices, and circuits are omitted so as not to obscure the description of the invention.

 Figure 1 is a functional block diagram illustrating a communication network according to an exemplary embodiment of the invention. In Figure 1, mobile station 230 is connected to a PSTN 260 via an MSC 250 and an RBS 240. The mobile station 230
20 travels between Location Areas LA1, LA2, LA3, LA4, each Location Area containing a plurality of cells 210. Although one mobile station is shown in Figure 1 for ease of illustration, the present invention is applicable to any number of mobile stations.

 In accordance with the invention, each time the mobile station 230 makes contact with the RBS 240 and the MSC 250, information identifying the cell in which the mobile
25 station is located is added to a Paging Hotlist that is maintained in the MSC 250. The mobile station 230 establishes contact with the RBS 240 and the MSC 250 through a connection on a Signalling Control Channel (SCCH), which may be a logical part of one of a set of predetermined control channels (CCHs) used by the network. Typically, each CCH corresponds to a respective cell, and this correspondence is established upon
30 configuration of the mobile communication network. The MSC 250 detects a

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communication from the mobile station 230 on the CCH, and from the configuration information the MSC 250 determines the cell in which the mobile station is located.

In any case, information identifying the cell in which the mobile station is located is transferred to a subscriber database maintained in the network, and the cell-identifying information is also stored in the Paging Hotlist in the subscriber database. For example in a network like the CMS30 system, the subscriber database can be included in a Mobile Switching Subsystem (MSS) 252 of the MSC 250, and the Paging Hotlist can be stored in the Mobile Telephony Visiting (MTV) subscriber portion 256 of a Location Register (LR) 254 of the MSC.

In accordance with the invention, the information in the Paging Hotlist is used for paging the mobile station 230 in a reduced area before paging the mobile station in a Location Area or performing a global page. In this way, the mobile station 230 is first paged in the cells where it is most likely to be found.

The Paging Hotlist may be a list, for example, of the most recent five to ten cells in which a mobile station has originated a call, answered a page, or registered its location, or to which the mobile station has been handed over. The Paging Hotlist may also include a cell in which the last call was set up, if this cell is different from the cell in which the mobile station last originated a call. Thus, the Paging Hotlist list represents a range of possible locations of the mobile station that at any given time is significantly narrower than the usual Location Area.

For example referring to Figure 1, assume that a mobile station 230 initially registered its location in cell A, was handed over to cell B, answered a page in cell C, originated a call in cell D, and finally was handed over to cell E. In this example, the Paging Hotlist would include identifying information for cells A, B, C, D, and E, rather than Location Areas LA1, LA2, and LA3.

To prevent duplication of cell-identifying information in the Paging Hotlist, a sorting operation can be performed when cell-identifying information is to be added to the list. When new cell-identifying information is to be added to the list and the list is full, the last (oldest) cell-identifying information in the list can be deleted. The new cell-identifying information can then be added to the top of the Paging Hotlist.

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Figure 2 illustrates a method for paging a mobile station according to an exemplary embodiment of the invention. Referring to Figure 2, the MSC 250 determines at step 100 whether an incoming call signal to a mobile station 230 has been detected. If an incoming call signal has been detected, the process proceeds to step 110 at which a
5 paging operation begins. At step 110, the MSC 250 issues pages within one or more of the cells identified by information listed in the Paging Hotlist. The MSC 250 can execute simultaneous, sequential, or a combination of both simultaneous and sequential paging in a plurality of different cells identified in the Paging Hotlist. For example, the MSC 250 may initially page the mobile station 230 in the cell in which the mobile station 230 is
10 currently registered. Next, at step 120, the MSC 250 determines whether a page response has been received from the mobile station 230. If a response has been received, the process proceeds to step 130, at which the call is routed to the mobile station 230 in the cell from which the page response originated.

If, at step 120, a page response has not been received from the initially paged
15 cell(s), the process proceeds to step 140, at which a determination is made whether there are additional possible cell(s) identified by information stored in the Paging Hotlist. If there are such cells, the process proceeds to step 150 at which simultaneous paging in some or all of the remaining cells identified in the Paging Hotlist is executed. The process then returns to step 120 and a determination is made whether a page response
20 signal has been received.

If no page response response has been received and it is determined at step 140 that there are no more possible cells remaining in the Paging Hotlist to page, the MSC 250 can optionally page the mobile station 230 within a Location Area at step 160. After completion of Location Area paging, a determination is made at step 170 whether a page
25 response signal has been received. If a page response has been received, the process returns to step 130 and call routing is performed. If a page response signal has not been received, the process proceeds to step 180, at which an optional global page is performed. Then, the process proceeds to step 190, at which a determination is made whether a page response signal has been received. If a page response signal has been received, call

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routing is performed at step 130. If a page response signal has not been received, call rerouting is performed at step 200.

According to the invention, a method and a system for paging a mobile station are provided by which the paging load imposed upon a mobile communication network is reduced without increasing the registration load. The paging area is reduced by using information identifying the cells in which the mobile station was located at the time the mobile station recently made contact with the communication network to determine the cells in which to page the mobile station. Since this information is already available in the network, using such information does not increase the registration load.

It will be understood that the invention is not limited to the particular embodiments that are described and illustrated above. The specification contemplates any and all modifications that fall within the scope of the invention as defined by the following claims.

WHAT IS CLAIMED IS:

1. In a mobile communication network including at least one mobile switching center and at least one mobile station, a method for paging a mobile station, the method
5 comprising the steps of:

establishing a list of cell-identifying information representing possible locations of the mobile station; and

selectively paging the mobile station within each cell identified by information in the list until a response is received.

2. The method of claim 1, wherein the step of selectively paging is repeated in each cell identified by information in the list until a response is received or selective
10 paging has been performed in every cell identified by information in the list.

3. The method of claim 2, wherein if selective paging has been performed in every cell identified by information in the list without receiving a response, the mobile
15 station is paged in a location area.

4. The method of claim 3, wherein if no response has been received after paging
20 the mobile station in the location area, a global page is performed.

5. The method of claim 1, wherein the step of establishing a list comprises:
making contact between the mobile station and the mobile switching center;
determining a cell in which the mobile station is located; and
25 adding information identifying the cell in which the mobile station is located to
the list.

6. The method of claim 1, wherein cell-identifying information is added to the list
each time the mobile station originates a call, answers a page, registers a location, or is
30 handed over to another cell.

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7. The method of claim 1, wherein the list includes information identifying at least five cells.

8. The method of claim 1, wherein the list includes information identifying a cell in which a call was last set up if this cell differs from a cell in which the mobile station last originated a call.

9. A mobile communication system, comprising:
at least one mobile switching center;
at least one mobile station; and
a database for storing a list of information identifying cells representing possible locations of the mobile station;
wherein the mobile switching center selectively pages the mobile station in each of the cells identified by information in the list until a response is received.

10. The system of claim 9, wherein the mobile switching center continues selectively paging the mobile station in each cell identified in the list until a response is received or the mobile switching center has selectively paged the mobile station in every cell identified in the list.

11. The system of claim 10, wherein if the mobile switching center has selectively paged the mobile station in every cell identified in the list without receiving a response, the mobile switching center pages the mobile station in a location area.

12. The system of claim 11, wherein if no response is received after the mobile switching center has paged the mobile station in the location area, the mobile switching center performs a global page.

13. The system of claim 9, wherein the list is established by making contact

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between the mobile station and the mobile switching center, determining a cell in which the mobile station is located, and adding information identifying the cell in which the mobile station is located to the list in the database.

5 14. The system of claim 13, wherein the database is included in the mobile switching center.

 15. The system of claim 14, wherein cell-identifying information is added to the list each time the mobile station originates a call, answers a page, registers a location, or
10 is handed over to another cell.

 16. The system of claim 9, wherein the list includes information identifying at least five cells.

15 17. The system of claim 9, wherein the list includes information identifying a cell in which a call was last set up if this cell differs from a cell in which the mobile station last originated a call.

Fig. 1

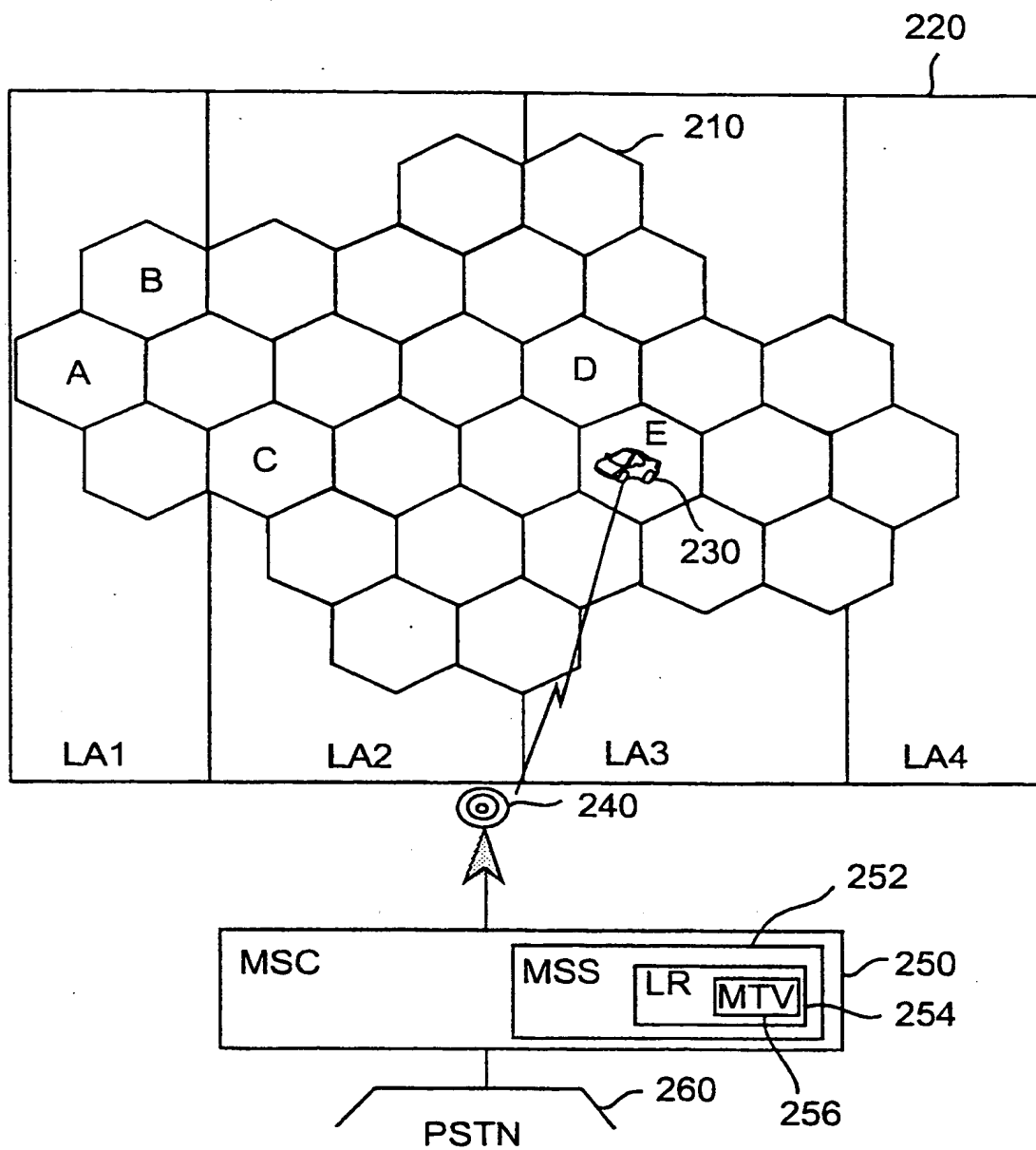
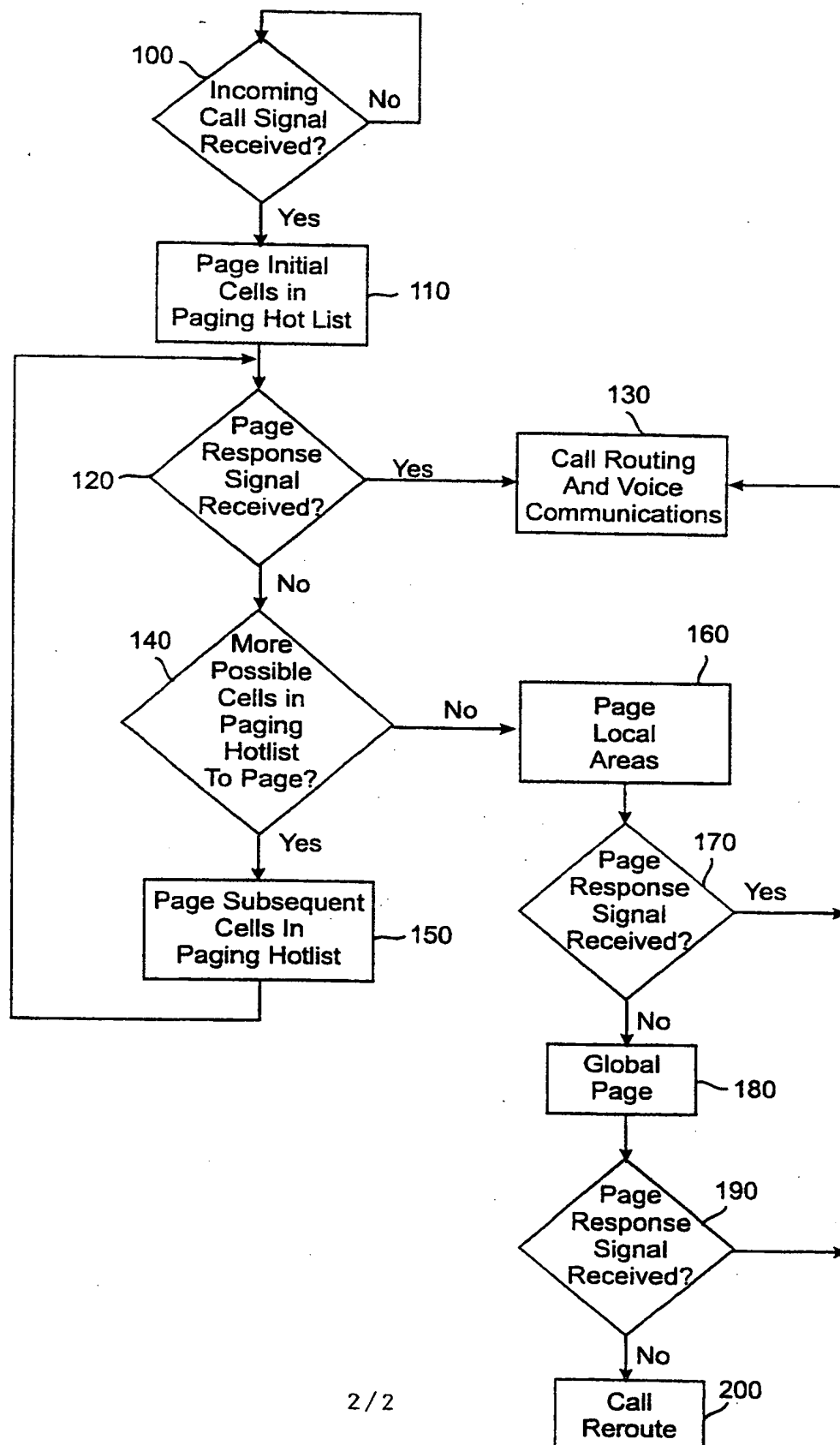


Fig. 2



INTERNATIONAL SEARCH REPORT

national Application No
PCT/SE 98/01165

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38 H04Q7/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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| Y | see column 2, line 46 - column 12, line 27 see column 19, line 46 - column 21, line 58 | 3,4,11, 12 |
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☒ Further documents are listed in the continuation of box C.

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| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT | | |
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